CLAIMS

What is claimed is:

1. A method of determining a consistency of stock comprising:

(a) providing a refiner, a sensor disposed in the refiner that senses a parameter inside the refiner, a processor, and a link between the sensor and the processor;

(b) sensing a parameter inside the refiner;

(c) communicating the sensed parameter to the processor; and

(d) determining consistency of stock using the sensed parameter.

2. The method according to claim 1 wherein the sensor comprises a temperature sensor and the sensed parameter comprises a temperature inside the refiner.

3. The method according to claim 2 wherein the refiner has a refining zone therein and the temperature inside the refiner is a temperature in the refining zone.

4. The method according to claim 3 wherein the temperature sensor is disposed in the refining zone.

5. The method according to claim 4 wherein the refiner further comprises a pair of spaced apart and opposed refiner plates and the temperature sensor is disposed in one of the refiner plates.

6. The method according to claim 1 wherein the sensor comprises a pressure sensor and the sensed parameter comprises a pressure inside the refiner.

7. The method according to claim 6 wherein the refiner has a refining zone therein and the pressure inside the refiner is a pressure in the refining zone.

8. The method according to claim 7 wherein the pressure sensor is disposed in the refining zone.

9. The method according to claim 8 wherein the refiner further comprises a pair of spaced apart and opposed refiner plates and the pressure sensor is disposed in one of the refiner plates.

10. The method according to claim 1 wherein the sensed parameter is communicated to the processor via the link between the sensor and the processor.

11. The method according to claim 10 further comprising a signal conditioner disposed between the sensor and the processor that receives a signal from the sensor and outputs a conditioned signal to the processor.

12. The method according to claim 1 wherein the refiner has a refining zone therein and a motor that provides power to the refiner, the sensed parameter comprises a temperature or pressure in the refining zone, and consistency is determined using the sensed parameter, a distribution of motor load in the refining zone, and an initial consistency value.

13. The method according to claim 1 wherein the refiner has a refining zone therein, the sensed parameter comprises a temperature or pressure in the refining zone, and consistency is determined using the sensed temperature or pressure, specific power, and an initial consistency value.

14. The method according to claim 1 wherein the refiner has a refining zone therein, the sensed parameter comprises a temperature or pressure in the refining zone, and consistency is determined using the sensed temperature or pressure, specific steam generation rate, dry wood throughput, latent heat of steam, specific power, wood heat capacity, water heat capacity, and an initial consistency value.

15. The method according to claim 1 wherein the refiner has a refining zone therein, the sensed parameter comprises a temperature or pressure in the refining zone, and consistency is determined as a function of radial position in the refining zone using the sensed parameter, specific power, and an initial consistency value.

16. The method according to claim 1 wherein the refiner has a refining zone therein, the sensed parameter comprises a temperature or pressure in the refining zone, and consistency is determined as a function of position in the refining zone using the sensed temperature or pressure, specific steam generation rate, dry wood throughput, latent heat of steam, specific power, wood heat capacity, water heat capacity, and an initial consistency value.

17. The method according to claim 1 wherein the refiner has a refining zone therein, the sensed parameter comprises a temperature or pressure in the refining zone, and consistency is based on the following equation:

$$C = \frac{1}{1+Z} .$$

18. The method according to claim 17 wherein the variable Z is determined using the following equation:

$$Z(r)=Z(r_i)\left(\frac{L(r)}{L(r_i)}\right)^{\frac{H_l}{\beta}}+\frac{H_s}{H_l}\left[\left(\frac{L(r)}{L(r_i)}\right)^{\frac{H_l}{\beta}}-1\right]-\frac{2\pi}{\dot{m}}L(r)^{\frac{H_l}{\beta}}\int r\overline{W}(r)L(r)^{\left(-\frac{H_l}{\beta}-1\right)}dr$$

19. The method according to claim 18 wherein the variable L(r) is a value for the latent heat of steam based on the sensed temperature or pressure and is determined using the following equation:

$$L(r)=\alpha+\beta T(r)$$

20. The method according to claim 1 wherein the refiner further comprises a pair of spaced apart and opposed refiner plates that define a refining zone therebetween, there are a plurality of sensors carried by one of the refiner plates that each sense the parameter inside the refiner, the parameter comprises a temperature or pressure in the refining zone, and consistency is determined as a function of position in the refining zone using each sensed temperature or pressure.

21. The method according to claim 1 further comprising a controller and the further step of the controller using the determined consistency to control some aspect of operation of the refiner.

22. The method according to claim 21 wherein the controller adjusts the mass flow rate of fiber into the refiner using the determined consistency.

23. The method according to claim 21 wherein the controller adjusts the flow rate of dilution water using the determined consistency.

24. A method of determining a consistency of stock in a refiner comprising:

(a) providing a refiner with a plurality of spaced apart and opposed refiner plates that define a refining zone therebetween, a sensor disposed in one of the plates that senses a parameter in the refining zone, and a processor that communicates with the sensor and the processor;

(b) sensing a parameter inside the refining zone;

(c) communicating the sensed parameter to the processor; and

(d) determining a consistency of stock using the sensed parameter.

25. A method of determining a consistency of stock in a refiner comprising:

(a) providing a refiner with a plurality of spaced apart and opposed refiner plates that define a refining zone therebetween, a sensor disposed in one of the plates that senses a parameter in the refining zone, and a processor that is in communication with the sensor;

(b) sensing a parameter inside the refining zone;

(c) outputting a signal;

(d) processing the signal to obtain a temperature or pressure in the refining zone; and

(e) determining a consistency of stock using the temperature or pressure obtained.

26. A method of determining a consistency of stock in a refiner comprising:

(a) providing a refiner with a plurality of spaced apart and opposed refiner plates that define a refining zone therebetween, a sensor disposed in one of the plates that provides a parameter in the refining zone, and a processor that is in communication with the sensor;

(b) obtaining a parameter inside the refining zone; and

(c) determining a consistency of stock in the refiner using the parameter.

27. A method of determining a consistency of stock in a refiner comprising:

(a) providing a refiner with a plurality of spaced apart and opposed refiner plates that define a refining zone therebetween, a sensor disposed in the refiner that provides a temperature or pressure inside the refiner, and a processor that is in communication with the sensor;

(b) obtaining a temperature or pressure inside the refiner; and

(c) determining a consistency of stock in the refiner using the obtained temperature or pressure.

28. A method of determining a consistency of stock in a refiner comprising:

(a) providing a refiner with a plurality of spaced apart and opposed refiner plates that define a refining zone therebetween, a sensor disposed in the refiner that provides a temperature or pressure inside the refiner, and a processor that is in communication with the sensor;

(b) obtaining a temperature or pressure inside the refiner;

(c) determining a latent heat of steam based on the obtained temperature or pressure using the following equation:

$$L(r) = \alpha + \beta T(r)$$

(d) determining a value Z(r) using the latent heat of steam calculated in step (c) using the following equation:

$$Z(r) = Z(r_i)\left(\frac{L(r)}{L(r_i)}\right)^{\frac{H_l}{\beta}} + \frac{H_s}{H_l}\left[\left(\frac{L(r)}{L(r_i)}\right)^{\frac{H_l}{\beta}} - 1\right] - \frac{2\pi}{\dot{m}} L(r)^{\frac{H_l}{\beta}} \int r\overline{W}(r) L(r)^{\left(-\frac{H_l}{\beta}-1\right)} dr$$

(e) determining a value C(r) using the value of Z(r) calculated in step (d) using the following equation:

$$C = \frac{1}{1+Z}.$$

29. A method of determining a consistency of stock in a refiner comprising:

(a) providing a refiner with a plurality of spaced apart and opposed refiner plates that define a refining zone therebetween, a sensor disposed in the refiner that provides a temperature or pressure inside the refiner, and a processor that is in communication with the sensor;

(b) obtaining a temperature or pressure inside the refiner; and

(c) determining a consistency of stock in the refiner using the obtained temperature or pressure.

30. A method of determining a consistency of stock comprising:

(a) providing a refiner that has a plurality of spaced apart and opposed refiner plates that define a refining zone therebetween, a motor that rotates one of the plates and which has a load during rotating the one of the refiner plates, a sensor disposed in the refiner that senses a temperature or pressure inside the refiner, a processor, and a link between the sensor and the processor;

(b) sensing a temperature or pressure inside the refiner;

(c) determining distribution of motor load in the refining zone; and

(d) determining consistency of stock using the sensed temperature or pressure, the distribution of motor load in the refining zone, and an initial estimated value of consistency.

31. A system of determining a consistency of a stock in a refiner, the system comprising:

(A) a plurality of refiner discs defining a refining zone;

(B) a sensor carried by the refiner that detects a process condition related to the consistency of the stock and outputs a signal;

(C) a signal conditioner that receives and conditions the signal; and

(D) a processor that receives the conditioned signal and that determines consistency of stock using the conditioned signal.

32. The system of claim 31 further comprising a controller that compares the determined consistency to a consistency setpoint and provides an output in response thereto that is used to control some aspect of operation of the refiner.

33. The system of claim 32 wherein the output of the controller is used controller some aspect of refiner operation to cause the determined consistency to converge with the consistency setpoint.

34. The system of claim 31 further comprising an array of sensors disposed in the refiner, wherein each sensor detects a process condition related to the consistency of the stock.

35. The system of claim 31, wherein the process condition detected is a temperature of the stock, wherein the processor averages the temperatures detected by the array of sensors, and wherein the processor determines the consistency of the stock using the average of the temperatures.

36. The system of claim 31, wherein the process condition detected is a temperature of stock entering the refiner and a temperature of stock in the refining zone, wherein the processor averages the temperatures detected by the array of sensors, and wherein the processor determines the consistency of the stock using the average of the

temperatures

37. The system of claim 31 wherein the sensor detects the process condition in real time.

38. The system of claim 31 further comprising a controller that regulates the refiner.

39. The system of claim 38 wherein the controller is temporarily put on hold until a new steady state process value has been reached when a change in some aspect of refiner is manually made.

40. The system of claim 31 wherein the sensor is exposed to the refining zone.

41. The system of claim 31 wherein the sensor is disposed in the refining zone.

42. The system of claim 31 wherein the sensor is located upstream of the refining zone.

43. The system of claim 31 wherein the process variable detected is a temperature of the stock in the refiner.

44. The system of claim 43 wherein the sensor detects the temperature of the stock in

the refining zone.

45. A system of claim 43 wherein the sensor detects the temperature of the stock upstream of the refining zone.

46. The system of claim 31 further comprising a pump that introduces dilution water into the disc refiner at a flow rate that can be varied, wherein the processor provides control output that alters a flow rate of a dilution water entering the disc refiner in response to the consistency determined.

47. The system of claim 31 wherein the processor provides a control output that alters a volumetric flow rate of the stock entering the disc refiner in response to the consistency determined.

48. The system of claim 31 further comprising a feed screw that has a rate of rotation that can be varied to change the mass flow rate of fiber entering the refiner and wherein the processor provides a control output that alters the rate of rotation of the feed screw in response to the consistency determined.

49. The system of claim 31 wherein the process variable detected is a pressure in the refiner.

50. The system of claim 49 wherein the process variable detected further comprises a temperature.

51. A system of determining a consistency of a stock in a refiner, the system comprising:

(A) a plurality of refiner plates defining a refining zone in which the stock is refined;

(B) a sensor disposed in one of the refiner plates from which a temperature or pressure in the refining zone is determined; and

(C) a processor that determines consistency of the stock using the determined temperature or pressure.

52. A system of determining a consistency of a stock in a refiner, the system comprising:

(A) a plurality of refiner plates defining a refining zone in which the stock is refined;

(B) a plurality of sensors disposed in one of the refiner plates from which at least one temperature or pressure in the refining zone is determined; and

(C) a processor that determines consistency of the stock in real time using at least one of the determined temperatures or pressures.

53. A system of determining a consistency of a stock in a refiner, the system comprising:

(A) a plurality of refiner plates defining a refining zone in which the stock is refined;

(B) an array of sensors disposed in one of the refiner plates that output signals relating to a characteristic of the stock in the refiner;

(C) a signal conditioner that receives the output signals from the array of sensors and outputs conditioned signals; and

(C) a processor that uses the conditioned signals to determine consistency of the stock in the refiner.

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